Institute for Energy Technology

NTNU
Norwegian University of Science and Technology

5th Annual International Workshop on Soft & Complex Matter

Themes: Microfluidics, clays, and active matter.

Norwegian Academy of Science and Letters

Drammensvegen 78, Oslo, Norway, October 21-22, 2018

Confirmed invited speakers:

Stig Ove Bøe (Oslo Univ. Hospital, Norway)
Andreas Carlson (Univ. Oslo, Norway)
Leide Cavalcanti (IFE, Norway)
Eric Clement (ESPCI-Paristech, France)
Paul Dommersnes (NTNU, Norway)
Maria Helena Godinho (Univ. NOVA de Lisboa, Portugal)
Irep Gözen (Univ. Oslo, Norway)
Yves Meheust (Univ. Rennes 1, France)
Leander Michels (Elkem, Norway)
Petra Rudolf (Univ. Groningen, Netherlands)
Barbara Ruzicka (Univ. Rome, Italy)

Invited postdocs/PhD students:

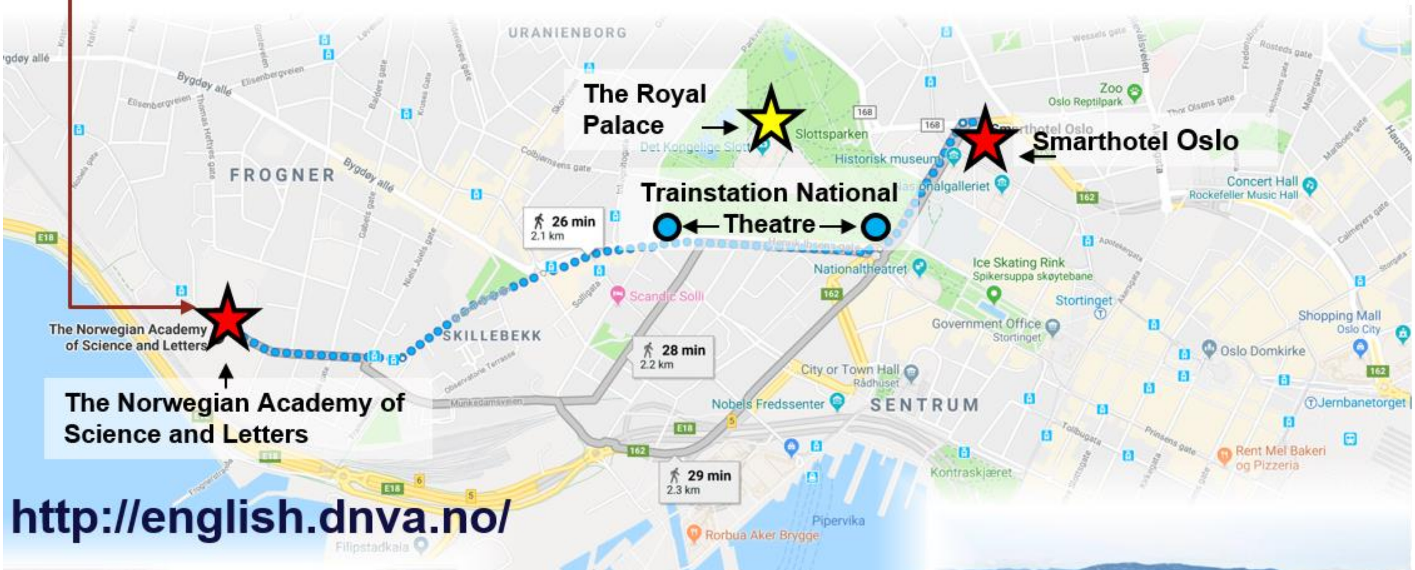
Paulo H. Michels-Brito (NTNU, Norway)
Kristoffer Hunvik (NTNU, Norway)
Gaspard Junot (ESPCI-Paristech, France)
Susanne Liese (Univ. Oslo, Norway)
Ville Liljeström (NTNU, Norway)
Etien Martinez (NTNU, Norway)
Osvaldo Trigueiro Neto (NTNU, Norway)
Hector Ignacio Ramos Urra (ESPCI-Paristech, France)
Pedro E. S. Silva (Univ. NOVA de Lisboa, Portugal)
Ana Catarina Trindade (NTNU, Norway)

Practical information to participants:

The workshop starts at 15:30 Oct. 21,
and ends at 14:00 Oct. 22, 2018

Organizers and contact:

Jon Otto Fossum
(jon.fossum@ntnu.no)
Ville Liljeström
NTNU, Trondheim, Norway



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Program and Book of Abstracts

5th Annual International Workshop Soft & Complex Matter

Norwegian Academy of Science and Letters, Oslo, Norway

October 21-22, 2018

Program Summary:

Time	Sunday October 21
	Norwegian Academy of Science and Letters, Drammensvegen 78 Oslo 
15:00-15:25	Arrival and Registration
15:25-15:30	**Jon Otto Fossum:** *Welcome*
15:30-15:45	**Stig Ove Bøe:** *Blood-mediated re-awakening of quiescent skin cells*
15:45-16:00	**Andreas Carlson:** *Curving to fly: Synthetic adaptation unveils optimal flight performance of whirling fruits*
16:00-16:15	**Leide Cavalcanti:** *Nanofluidics in smectite clays*
16:15-16:30	**Eric Clement:** *E. Coli "super contaminates" narrow channels fostered by broad motor switching statisitics*
16:30-16:45	**Discussions**
16:45-17:00	**Paul Dommersnes:** *Active condensed matter from electro-hydrodynamically propelled particles*
17:00-17:15	**Maria Helena Godinho:** *Hygroscopic movements of cellulose-based helices from skeletons of plants*
17:15-17:30	**Yves Meheust:** *Millifluidic investigations of solute transport and of its relationship to electric conductivity*
17:30-17:45	**Petra Rudolf:** *Molecular motors and switches at surfaces*
17:45-18:00	**Discussions**
18:00-18:15	**Barbara Ruzicka:** *Gel and glassy states in a charged colloidal clay*
18:15-18:30	**Irep Gözen:** *Lipid nanotubes: A possible route to protocell formation and growth*
18:30-18:45	**Leander Michels:** *Water vapor diffusive transport in a smectite clay: Cationic control of normal vs. anomalous diffusion*
18:45-19:00	**Ana Trindade:** *Tuning photonic properties of cellulose-clay nanostructures*
19:00-19:15	**Discussions**
19:15-23:00	**Dinner including and followed by discussions**

Monday October 22	Time
Gaspard Junot: *Swimming in complex environments*	**10:00-10:15**
Pedro E. S. Silva: *Producing fibres with helical shapes using UV light*	**10:15-10:30**
Ville Liljeström: *Assembly and fixation of microparticles confined to interfaces and droplets*	**10:30-10:45**
Susanne Liese: *Modeling Scaffoldless Vesicle Formation*	**10:45-11:00**
Discussions	**11:00-11:20**
Kristoffer Hunvik: *Sorption of CO and CO2 in/on clays*	**11:20-11:30**
Etien Martinez: *Challenge collective behaviour*	**11:30-11:40**
Paulo H. Michels-Brito: *Surface modification of clay for self-assembled materials*	**11:40-11:50**
Osvaldo Trigueiro Neto *Photoacoustics*	**11:50-12:00**
Discussions	**12:10-12:20**
Lunch including and followed by discussions	**12:20-14:00**
Departure 	**14:00 -**

Sunday October 21:

15:00 - 15:25 Registration

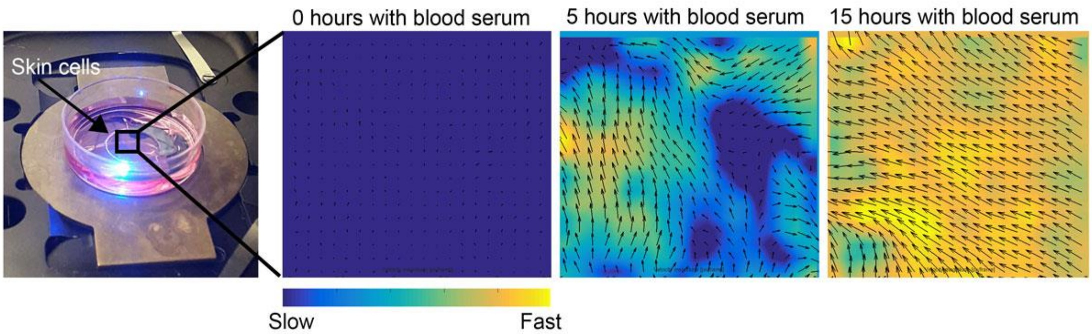
15:25 - 15:30 Jon Otto Fossum, NTNU, Trondheim, Norway: **Welcome**

15:30 - 15:45 Stig Ove Bøe

Department of Medical Biochemistry, Oslo University Hospital, Norway

Blood-mediated re-awakening of quiescent skin cells

During a life time, an average human being is exposed to several thousand injuries ranging from minor cuts or scratches to traumatic injuries or surgery. Generation of new skin through re-epithelialization represents a crucial part of the wound healing process and is widely used as a defining parameter of successful wound closure. During the course of this process, millions of skin cells, which are located in close proximity to the wound edges, become detached from their fixed positions, aligned and prompted to migrate collectively into the open wound. We have recently demonstrated that the transition from static quiescent keratinocytes to collectively migrating keratinocytes can be activated in a cell culture system through consecutive serum deprivation and serum re-stimulation [1]. In this model, which mimics serum-mediated activation of epithelial cells after wounding, a burst of global collective migration is generated throughout the cell culture in the absence of a wound edge. Migrating cohorts consisting of hundreds of thousands of cells reach several millimeters in size and display dependencies on epidermal growth factor receptor-mediated signaling, a supra-cellular actinomyosin network, self-propelled polarized migration, and a G1/G0 cell cycle environment. While collective cell motion arises independently of wound edges, we find that cell motility direction is highly influenced by the presence of a free edge. In the present talk non-random motility patterns in serum-activated keratinocytes in the presence of wound edges will be discussed.



1. Lang, E. et al. Coordinated collective migration and asymmetric cell division in confluent human keratinocytes without wounding. Nature communications 9, 3665 (2018).

15:45 - 16:00 Andreas Carlson

Department of Mathematics, University of Oslo, Norway

Curving to fly: Synthetic adaptation unveils optimal flight performance of whirling fruits

Appendages of seeds, fruits and diaspores (dispersal units) are essential for their wind dispersal, as they act as wings and enable them to fly. Whirling fruits generate an auto-gyrating motion from their sepals, a leaf like structure, which curve upwards and outwards, creating a lift force that counteracts gravitational force. The link of the fruit's sepal shape to flight performance, however, is as yet unknown. We develop a theoretical model and perform experiments for double-winged bio-mimetic 3D-printed fruits, where we assume that the plant has a limited amount of energy that it can convert into a mass to build sepals and, additionally, allow them to curve. Both hydrodynamic theory and experiments involving synthetic, double-winged fruits show that to produce a maximal flight time there is an optimal fold angle for the desiccated sepals. A similar sepal fold angle is found for a wide range of whirling fruits collected in the wild, highlighting that wing curvature can aid as an efficient mechanism for wind dispersal of seeds and may improve the fitness of their producers in the context of an ecological strategy.

16:00 - 16:15 ***Leide P. Cavalcanti[1], Heloisa N. Bordallo[2,3], Kenneth D. Knudsen[1,4], Jon Otto Fossum[4]***

[1]Institute for Energy Technology (IFE), Kjeller, Norway, [2]Univ. of Copenhagen, Denmark, [3]European Spallation Source, Sweden, [4]Norwegian Univ. of Science and Technology (NTNU), Trondheim, Norway

Nanofluidics in smectite clays

This talk presents clay minerals as possible materials for the study of nanofluidics. Clays are nano-silicate layered materials with structural properties that can be modified and controlled for intercalation and transport of foreign molecules. Intercalation of water in smectite clays occurs naturally and has been extensively studied with a wide range of techniques, among them neutron [1] and X-ray scattering [2]. Experiments and simulations have shown that also CO_2 can intercalate in smectite clays in gaseous and liquid form [3]. We have demonstrated that under certain conditions of pressure and temperature, fluorohectorite clays are able to capture a large amount of CO_2, depending on the type of interlayer cation [4,5,6]. We have investigated fluorohectorite clays with three different cations (Na^+, Ni^{+2} and Li^+), showing that Li-fluorohectorite clay is able to retain CO_2 up to a temperature of 35°C, at ambient pressure, suggesting the formation of a stable CO_2 complexation with the clay interlayer cation. Here we show that clays could also be used as a model for nanofluidics. New physical effects were shown to be possible in “ultrasmall confined spaces” [7] such as higher viscosity or higher mobility among others. We show some examples and perspectives.

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3. Giesting et al. XRD Study of K- and Ca-Exchanged Montmorillonites in CO2 Atmospheres. Environ. Sci. Technol. 2012, 46, 5623.
4. Hemmen et al. X-Ray Studies of CO2 Intercalation in Na- Fluorohectorite Clay at near-Ambient Conditions. Langmuir 2012, 28, 1678.
5. Michels et al. Intercalation and Retention of CO2 in a Smectite Clay Promoted by Interlayer Cations. Sci. Rep. 2015, 5, 8775.
6. Cavalcanti. A Nano-Silicate Material with Exceptional Capacity for CO2 Capture and Storage at Room Temp. Sci. Rep. 2018, 8, 11827.
7. Xu, Y. Nanofluidics: A New Arena for Materials Science. Adv. Mater. 2018, 30 (3), 1–17.

16:15 – 16:30 N. Figueroa-Morales[1] , A. Rivera[2] , E. Altshuler[2], R.Soto[3], Anke Lindner[1] and Eric Clément[1]

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E. Coli "super contaminates" narrow channels fostered by broad motor switching statisitics

The motility of E. coli bacteria is a "run-and-tumble" process, where the changes of direction correspond to a switch in the direction of the flagellar motor rotation. Based on the study of 3D bacterial trajectories, the run time distribution has been described as an exponential decay of characteristic time close to 1s [1]. More recent results have demonstrated that the generic response for the distribution of run times is not exponential, but broad [2]. We investigate the consequences of the motor statistics on the macroscopic bacterial transport. During upstream contamination processes in confined channels – studied here in great detail thanks to a video-scanning technique– we have identified a phenomenon we call "super-contamination", i.e., a very fast microbial invasion over large distances along a channel, especially against flows. Using a stochastic model considering bacterial dwelling times on the surfaces related to the run times, we are able to reproduce qualitatively and quantitatively the evolution of the contamination profiles when considering a broad distribution of run times. However, the model fails to reproduce the qualitative dynamics when the classical exponential run and tumble distribution is assumed. Our results reveal that the macroscopic transport of bacteria responsible for many kinds of infections is essentially connected to the motor rotation statistics [3].

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2. E. Korobkova, T. Emonet, J. MG Vilar, T. S Shimizu, and P. Cluzel. From molecular noise to behavioural variability in a single bacterium. Nature, 428(6982):574–578, 2004.
3. N.Figueroa-Morales, A. Rivera, E. Altshuler, R. Soto, A. Lindner, E. Clement, E.coli ``super-contaminates" narrow channels fostered by broad motor switching statistics, preprint (2018).

16:30 – 16:45 Discussions

16:45 – 17:00 Paul Dommersnes and Jon Otto Fossum

Department of Physics, Norwegian University of Science and Technology, Norway

Active condensed matter from electro-hydrodynamically propelled particles

Insulating particles or drops suspended in a carrier liquid may start to rotate with a constant frequency when subject to an electric field. This is known as the Quincke rotation electro- hydrodynamic instability. A single isolated rotating particle exhibit no translational motion at low Reynolds number, however interacting rotating particles may move relative to one another or in the presence of a wall. Here we present a system consisting of Quincke rotating micro-beads that self-organize into self-propelled clusters.

17:00 – 17:15 ***Ana Almeida[1], Lara Querciagrossa[2], Pedro Silva[1], Filipa Gonçalves[1], João Canejo[1], Pedro Almeida[1,3], Maria Godinho[1*] and Claudio Zannoni[2*]***

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[2]Dipartimento di Chimica Industriale "Toso Montanari" and INSTM, Universita' di Bologna, viale Risorgimento 4, 40136 Bologna, Italy
[3]Área Departamental de Física, Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa, 1959-007 Lisbon, Portugal

Hygroscopic movements of cellulose-based helices from skeletons of plants

Cellulose-based responsive hygroscopic hierarchical structures, existing in plants, have a crucial role on their survival. Among these materials are hygroscopic dead tissues that are programmed for transporting and self-planting the seeds. These structures, with their cellulose-based skeletons, are flexible, lightweight, low cost, and in many ways outperform any current materials that artificial technologies can produce; yet they are mostly destroyed and scarcely exploited. In this work, we show that responsive hierarchical cellulose-based micro/nano helical structures, existing in sclerenchymal tissues, can be isolated preserving their motility. Moreover, we demonstrate that the optical characteristics of the isolated structures can be tuned and their chirality inverted opening routes for the production of next generation soft interactive materials.

17:15 – 17:30 ***Yves Méheust [1,*], Joaquin Jimenez-Martinez[2], Régis Turuban[1], Tanguy Le Borgne[1], Damien Jougnot[3], Hervé Tabuteau[4], Niklas Linde[5]***

[1]Géosciences Rennes (UMR 6118), Univ. Rennes 1, CNRS, Rennes, France
[2]EAWAG and ETH Zürich, Zürich, Switzerland
[3]Sorbonne Université, CNRS, UMR 7619 METIS, Paris
[4]Institut de Physique de Rennes, Univ. Rennes 1, Rennes, France
[5]ISTE, Univ. Lausanne (UNIL), Lausanne, Switzerland

Millifluidic investigations of solute transport and of its relationship to electric conductivity

Keywords: *Porous media, micromodels, reactive transport, mixing, two-phase flow, electric transport.*
Pore scale characterization of flow velocities and concentration spatial distributions is a key to understanding non-Fickian transport, mixing and reaction in porous media. We use millifluidic setups to investigate such processes in transparent saturated and unsaturated porous media, at the pore scale. The porous media are quasi-two-dimensional, consisting of a Hele-Shaw cell containing cylindrical grains. They are made by soft lithography with full control on a geometry containing thousands of grains. The setup allows for unsaturated flows, be it primary drainage/imbibition, or the injection of two fluids (f. e. water and air) at the same time. A camera positioned above the flow cell records the distributions of fluid phases, at regular times, providing also the position of solid tracers and spatially-resolved images of light emissions inside the flow cell. The pore scale velocity field is measured from the tracking of solid tracers (microspheres), while full pore scale concentration fields are measured accurately in passive transport experiments, using fluorescein and converting the emitted light intensities into solute concentrations. Using two chemo-luminescent liquids, the reaction of which produces photons in addition to the reaction product(s), we can also measure the local production rate of the reaction product as the reactive liquids flow through the system. We confront the experimental pore scale data to numerical simulations and models that upscale transport and mixing properties. We shall address two examples of studies based on this approach. Firstly, we shall discuss how medium desaturation affects solute mixing [1,2]. Secondly we shall discuss the link between the transport of charged chemical species and electrical signals that can be measured in the experimental cell [3], and the subsequent implications in terms of electrical imaging of the subsurface.

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2. J. Jiménez-Martínez, T. Le Borgne, H. Tabuteau, and Y. Méheust (2015), Non-Fickian dispersion and mixing in unsaturated porous media, Water Resour. Res. 53.
3. D. Jougnot, J. Jiménez-Martínez, R. Legendre, T. Le Borgne, Y. Méheust, N. Linde (2018), Adv.

17:30 – 17:45 ***Petra Rudolf***

Department, Zernike Institute for Advanced Materials, University of Groningen, Netherlands

Molecular motors and switches at surfaces

Nano-engines and molecular motors form the basis of nearly every important biological process. In contrast to this solution chosen by Nature for achieving complex tasks, all of mankind's present day technologies function exclusively through their static or equilibrium properties. In this presentation I shall discuss how molecular engines that allow movements at the molecular level can be coupled to the macroscopic world to transport macroscopic objects like drops of liquid over a surface. I shall also discuss how molecular switches, which can be addressed with light and charge transfer, can be employed for modulating conductivity of a molecular layer and for "read and write" functions.

17:45 – 18:00 ***Discussions***

18:00 – 18:15 ***Roberta Angelini, Emanuela Zaccarelli, Barbara Ruzicka***

Institute of Complex Systems-CNR and Physics Department, Sapienza University, P.zle A. Moro 2, Rome 00185, Italy

Gel and glassy states in a charged colloidal clay

One of the most striking features of soft matter systems is their ageing behaviour and the existence of new phases and states besides the ones commonly experienced in atomic or molecular systems. Among these colloidal clays have emerged as suitable candidates to investigate the formation of multiple arrested states.

In this presentation we show the results obtained on dilute aqueous dispersions of Laponite®, an industrial synthetic clay that dispersed in water originates a charged colloidal system of nanometer-sized discotic platelets with inhomogeneous charge distribution and directional interactions. The presence of competing attractive and repulsive terms in the interactions, combined with the directionality of the face-rim charge interactions and with the anisotropic shape of Laponite, determine a nontrivial aging dynamics towards multiple arrested states. Therefore the system spontaneously evolves with waiting time from a liquid phase with low viscosity to an arrested gel and/or glass state. In particular two different disordered arrested states of gel and glass have been obtained respectively for low ($C_w < 2.0$ %) and high ($C_w \geq 2.0$ %) clay concentrations in salt free water conditions.

The arrested state at low concentration is governed by attractive interactions and through DLS and SAXS experiments, supported by numerical simulations, we have found the first experimental evidence of empty liquid and equilibrium gel [1], new concepts formulated for patchy colloids [2] of different shapes, patterns and functionalities.

On the other side the comparison between DLS, dilution and SAXS experiments and theoretical and numerical results have permitted to individuate a high concentration ($C_w \geq 2.0$ %) Wigner glass [3] state, i.e. an arrested state formed by disconnected particles or clusters and stabilized by the electrostatic repulsion. Moreover, through SAXS, XPCS, rheology and numerical experiments, we have found that the attractive interactions are playing a role also in this case and that even in the glassy state the interactions among the colloidal particles are still evolving with waiting time, originating an interesting dichotomic behaviour [4] and a spontaneous glass–glass transition [5]. Two different glassy states are distinguished with increasing waiting time: the system spontaneously evolves from a first glass, dominated by long-range screened Coulombic repulsion (Wigner glass) to a second one, stabilized by orientational attractions (Disconnected House of Cards glass), occurring after a much longer time.

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2. Bianchi E., Largo J., Tartaglia P., Zaccarelli E., Sciortino F. (2006). Phase diagram of patchy colloids: towards empty liquids. Phys. Rev. Lett. 97, 168301.
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4. Angelini R., Zulian L., Fluerasu A., Madsen A., Ruocco G., Ruzicka B (2013). Dichotomic Aging Behaviour in a Colloidal Glass Soft Matter 9, 10955.
5. Angelini R., Zaccarelli E., de Melo Marques F. A., Sztucki M., Fluerasu A., Ruocco G., Ruzicka B. (2014). Glass-glass transition during aging of a colloidal clay. Nature Communications 5, 4049.

18:15 – 18:30 ***Elif Senem Koksal, Susanne Liese, Ilayda Kantarci, Ragni Olsson, Andreas Carlson, Irep Gözen***

Faculty of Medicine, University of Oslo, Norway

Lipid nanotubes: A possible route to protocell formation and growth

Membrane-enclosed cellular compartments create spatially distinct microenvironments which confine and protect biochemical reactions in the cell. On the early Earth, the autonomous formation of compartments is presumed to have enabled encapsulation of nucleotides, satisfying a starting condition for the emergence of life. Recently, surfaces have become into focus as potential platforms for the self-assembly of prebiotic compartments, as notably enhanced vesicle formation was reported in the presence of solid interfaces. The detailed mechanism of such formation at the mesoscale however is still under discussion.

Here we report on the spontaneous transformation of lipid reservoirs on solid substrates to unilamellar membrane compartments through a sequence of topological changes, proceeding via a network of interconnected lipid nanotubes. We show that this transformation is entirely driven by surface-free energy minimization and does not require hydrolysis of organic molecules, or external stimuli such as electrical currents or mechanical agitation. The vesicles grow by taking up the external fluid environment, and can subsequently separate and migrate upon exposure to hydrodynamic flow. This may explain, for the first time, the details of self-directed transition from weakly organized bioamphiphile assemblies on solid surfaces to protocells with secluded internal contents.

18:30 – 18:45 ***L. Michels[1,*], Y. Méheust[2,*], M.A.S.Altoé[3], E.C. dos Santos[1,4], H. Hemmen[1], R. Droppa Jr[5], J.O. Fossum[1*], G.J. da Silva[3]***

[1]NTNU -Norwegian University of Science and Technology, Department of Physics, NO-7495, Trondheim, Norway
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[5]Centro de Ciências Naturais e Humanas, UFABC - Universidade Federal do ABC, 09.210-580, Santo André – SP, Brasil

Water vapor diffusive transport in a smectite clay: Cationic control of normal vs. anomalous diffusion

Transport of chemical species in porous media is ubiquitous in subsurface processes, including contaminant transport, soil drying and soil remediation. We study vapor transport in a multiscale porosity material, a smectite clay, in which water molecules travel in mesopores/macropores between the clay grains but can also intercalate inside the nanoporous grains, making them swell. The intercalation dynamics is known to be controlled by the type of cation; in this case exchanging the cations from Na^+ to Li^+ accelerates the dynamics. By inferring mesoporous humidity profiles from a space-resolved measurement of grain swelling, and analyzing them with a fractional diffusion equation, we show that exchanging the cations changes mesoporous transport from Fickian to markedly subdiffusive. This results both from modifying the exchange dynamics between the mesoporous and nanoporous phases, and from the feedback of transport on the medium's permeability due to grain swelling. An important practical implication is a large difference in the time needed for vapor to permeate a given length of the clay depending on the type of intercalated cation.

18:45 – 19:00 ***<u>Ana Catarina Trindade</u>[1], Susete Fernandes[2], Ville Liljeström[1], Maria Helena Godinho[2], J.-O. Fossum[1]***

[1]Department of Physics, Norwegian University of Science and Technology, Trondheim, Norway
[2]Departamento de Ciência dos Materiais and CENIMAT/I3N, Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa, Campus de Caparica, 2829-516 Caparica, Portugal

Tuning photonic properties of cellulose-clay nanostructures

Solid films prepared from cellulose nano crystals (CNCs) present iridescence and selective reflection of left circularly polarized (LCP) light [1,2], while nano clay particles organize as lamellar structures in the solid state. It is well known that aqueous suspensions of sodium fluorohectorite (NaFh) clay biaxial platelets can form a nematic uniaxial liquid crystalline phase [3].

In this work we dissolved different quantities of cellulose nanorods in the clay nematic liquid crystalline suspensions (cellulose-NaFh nanocrystals (CNC/NaFh)) and we observed that the clay nematic structure undergoes a helical distortion by dissolving cellulose nanorods. Above a certain critical concentration the suspensions became iridescent with a left handed structure.

In order to preserve the photonic characteristics of the clay/nano rods suspensions solid films were prepared. We demonstrate that not only iridescent films can be produced but also their selective reflection of LCP light channel preserved.

The colors reflected by the films can vary from blue to red depending on the amount of CNCs added to the system.

This work demonstrates that the chirality-transfer, at the nano scale, induced by the CNCs on the clay nano platelets nematic phase translates into the photonic characteristics of solid films produced from aqueous CNCs/clay suspensions.

The precursor suspensions and the solid films were investigated by using different techniques as scanning electron microscopy (SEM), atomic force microscopy (AFM) and polarizing optical microscopy (POM).

This work opens new horizons to the design and control of nano-structured materials offering the possibility to produce material surfaces or coatings with engineered and targeted optical properties. Such structurally colored materials represent a viable alternative to toxic chemical pigment colorants: the optical response is independent of the chemical composition of the medium and can be tailored by controlling its interaction with light on the nano-scale.

1. S. Fernandes et al., Mind the Microgap in Iridescent Cellulose Nanocrystal Films, Adv. Mater. 2017, 29, 1603560.
2. S. Fernandes et al., Structural color and iridescence in transparent sheared cellulosic films, Macromolecular Chemistry and Physics 2013, 214(1), 25-32.
3. H. Hemmen et al., The Frederiks transition in an aqueous clay suspension, Revista cubana de Fisica 2012, 29(1E), 59-61.

19:00 - 23:00 ***Workshop Dinner***

Monday October 22:

10:00 – 10:15 ***<u>G.Junot</u> [1], A. Lindner [1] H.Auradou[2], H. Ramos-Urra[1], P.G. Dommersnes[3], J-O Fossum[3], and E. Clément [1]***

[1]Laboratoire Physique et Mécanique des Milieux Hétérogènes, CNRS - ESPCI Paris, PSL Research University, Universités Denis Diderot, Sorbonne-Universités.10, rue Vauquelin, Paris, France
[2]Laboratoire FAST, Univ. Paris Sud, CNRS, University Paris-Saclay, F-91405, Orsay, France
[3]Physics Department, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

Swimming in complex environments

Understanding the motility and spreading of micro-organisms in complex environments is a timely question relevant to many fundamental and technological issues. This is for example a crucial question in the context of medicine as it can control several physiological functions. It is also relevant to technologies of drug delivery or environmental studies aiming at understanding the spreading of bio-contaminants in soils or the stability of ecological niches. We review here some recent results on swimming properties of E.coli in various conditions for example in a flow or in complex fluids.

Thanks to a 3D Lagrangian tracking technique, we are able to follow E.coli bacteria and obtain its 3D motion in different environment. First we will present our work about the statistic of the so called run and tumble process. We show that the distribution of run time is not Poisson distributed but exhibits long tail as a power law. Then we will focus on bacteria under flow and study the trajectory of E.coli smooth swimmers that we will describe using an active Bretherton-Jeffery model. Finally, we will focus on bacteria in clay and see how the clay concentration affects the swimming velocity of the bacteria.

1. T. Darnige, N. Figueroa-Morales, P. Bohec, A. Lindner and E. Clément, Lagrangian 3D tracking of fluorescent microscopic objects under flow, Review of Scientific Instruments, 88, 055106 (2017).
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3. G.Junot, N. Figueroa-Morales, Thierry Darnige, A. Lindner, H. Auradou and E.Clément, Swimming bacteria in a Poiseuille flow : the quest for active Betherton-Jeffery trajectories, in preparation (2018).

10:15 – 10:30 ***Pedro E. S. Silva*[1], *F. V. de Abreu*[2], *M. H. Godinho*[11]**

[1]CENIMAT/I3N, Department of Materials Science, NOVA University of Lisbon, Campus da Caparica, 2829-516 Caparica, Portugal.
[2]Department of Physics/I3N, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

Producing fibres with helical shapes using UV light

10:30 – 10:45 ***Ville Liljeström, Asbjørn Torsvik Krüger, Osvaldo Trigueiro Neto, Paul Dommersnes, Jon Otto Fossum***

Department of Physics, Norwegian University of Science and Technology, Trondheim, Norway

Assembly and fixation of microparticles confined to interfaces and droplets

Microparticles attach efficiently to liquid interfaces due to capillary forces [1]. On the other hand, an electric field can cause shear stress on a curved liquid-liquid interface between two poorly electrically conducting liquids [2-4]. E.g. for a silicon droplet in castor oil this results in a so called Taylor flow [2], which implies that particles carried by the liquid will be driven to the "equator" of the droplet, thus forming an electrohydrodynamically (EHD) formed equatorial ribbon [3,4]. We study such EHD self-assembly of various microparticles at curved fluid-fluid interfaces, i.e. droplets or trapped droplets. Our goal is to study how modulation of the physical properties of the particles can be exploited in order to control the formation and stability of patterns at liquid-liquid interfaces.

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2. Taylor G. Studies in electrohydrodynamics. I. The circulation produced in a drop by an electric field. Proc R Soc A 291, 159–66 (1966)
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10:45 – 11:00 ***Susanne Liese***

Department of Medical Biochemistry, Oslo University Hospital, Norway

Modeling scaffoldless vesicle formation

Membrane vesicles are ubiquitous in biology. They serve as compartments to segregate and transport biological material and play a vital role in cell communication. In eukaryotic cells, the formation of endosomal intraluminal vesicles (ILV), is essential for the cell functionality, where encapsulating trans-membrane proteins and cargo material in vesicles is a critical step in lysosomal protein degradation, cargo recycling and exosome release. In general, the formation of vesicles is causes by forces acting within the membrane. These forces originate for instance from transmembrane protein, an external protein scaffold or the interaction with the surrounding fluid. In the case of ILV formation membrane associated proteins are known to cause the membrane deformation. However, the biophysical mechanism behind the membrane remodeling is not yet understood.

In my work, I investigated vesicle formation in a coarse-grained model, describing the equilibrium shape of a membrane by an elastic two dimensional Helfrich-type sheet. Based on this model we could identify a combination of effective transmembrane protein interaction and protein crowding as the origin of protein induced membrane deformation.

11:00 – 11:20 ***Discussions***

11:20 – 11:30 ***Kristoffer Hunvik***

Norwegian University of Science and Technology, Department of Physics, NO-7495, Trondheim, Norway

Sorption of CO and CO_2 in/on clays

11:30 – 11:40 ***Etien Martinez***

Norwegian University of Science and Technology, Department of Physics, NO-7495, Trondheim, Norway

Challenge active turbulence

11:40 – 11:50 ***Paulo H. Michels-Brito***

Norwegian University of Science and Technology, Department of Physics, NO-7495, Trondheim, Norway

Surface modification of clay for self-assembled materials

11:50 – 12:00 ***Osvaldo Trigueiro Neto***

Norwegian University of Science and Technology, Department of Physics, NO-7495, Trondheim, Norway

Photoacoustics

12:00 – 11:00 ***Discussions***

12:00 - 14:00 ***Workshop Lunch***

14:00 - ***Departure***